THE ACCELERATED RETRIEVAL, TREATMENT, AND DISPOSAL OF TANK WASTE AND CLOSURE OF TANKS AT THE HANFORD SITE ENVIRONMENTAL IMPACT STATEMENT:

A GUIDE TO UNDERSTANDING THE ISSUES

EFFECTIVE DATE: JANUARY 13, 2003

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SIGNATURE PAGE

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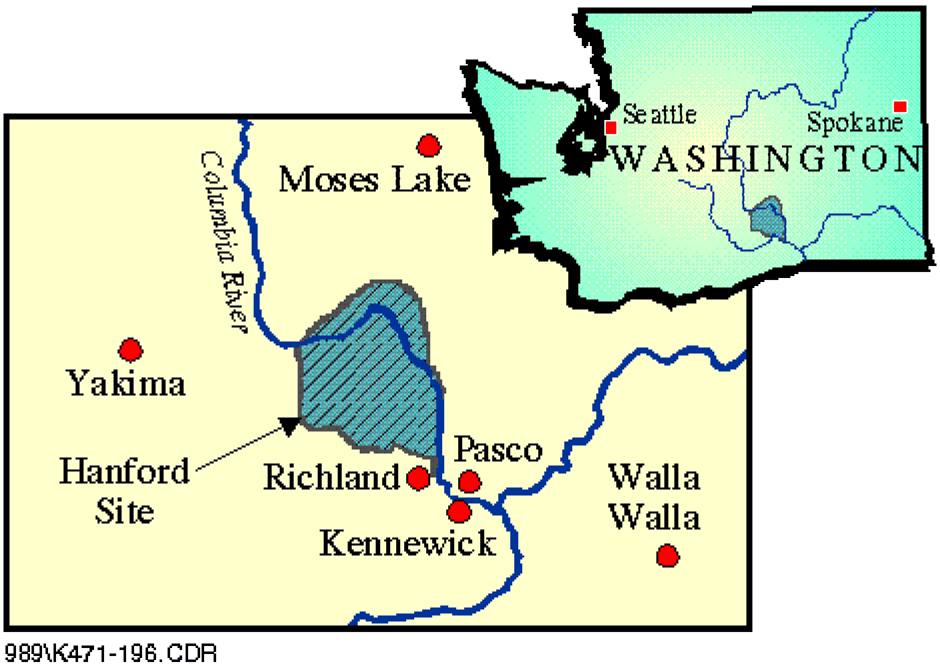
The Hanford Site is a 560-square-mile site managed by the U. S. Department of Energy (DOE) formerly dedicated to the production of plutonium and other nuclear materials. The site is located in the southeastern part of Washington State just north of where the Snake and Yakima Rivers meet with the Columbia River, about 25 miles north of the Oregon border.

Hanford Site and Vicinity Map



Over the years of production (1943-1987), the Hanford Site produced approximately 60% (73 tons) of DOE nuclear-weapon- and reactor-fuel-grade plutonium. The end product and associated *waste* generated from the manufacturing process were like those in no other industry. Approximately 110,000 tons of specially designed uranium metal were exposed to neutrons, or *irradiated* in 9 nuclear reactors and reprocessed in 4 chemical plants. These operations created large volumes of waste, some of which was transferred to underground tanks for long-term storage.

Today, that *tank waste* is stored in 177 underground storage tanks. They are the focus of this guide. All together, they contain about 53 million gallons of waste. Half of the *radioactivity* currently at Hanford rests in these tanks. Most of the remaining half is in spent nuclear fuel now being transferred from a reactor site near the Columbia River to the Hanford plateau, several miles from the river, and in cesium and strontium capsules in storage at Hanford.

Needed — Public Input

Many people are concerned about Hanford's tank waste because of the potential for tank leaks, near-term safety issues, and long-term needs for waste treatment, waste *disposal*, and *closure* of the tank systems. The tank wastes, if not properly treated and disposed, and the tank systems, if not properly closed, may have even longer-term impacts on the environment and health of future generations of residents of the surrounding area. Never before has a nuclear waste cleanup effort of this scale been attempted anywhere in the world. The work will be expensive and will take a long time. Cost estimates range upward to several billions of dollars, giving both the taxpayers and Congress a major reason to be interested in tank waste issues.

Public input is requested on decisions about how to deal with Hanford's tank wastes and tanks. Active public input and involvement are critical to those decisions. This input requires a basic understanding of the technical issues relating to tank waste retrieval, treatment, and disposal and to tank system closure itself.

What Is the Immediate Issue?
Why Does DOE Need to Make Decisions?

DOE wants to begin a process that will lead to closing four waste tanks by the end of 2004, and all 177 tanks by 2033. Also, DOE decided in 1997 to build a large plant to immobilize the wastes from the tanks by making glass out of it, a process called "vitrification." But that plant, known as the Waste Treatment Plant (WTP), will at most be able to vitrify about half the waste volume if it is allowed to run until 2046. DOE needs to decide how best to treat the remaining wastes by 2028, which is the completion date agreed to with the Washington State Department of Ecology (Ecology) in the *Hanford Federal Facility Agreement and Consent Order*, known as the Tri-Party Agreement. This could include supplemental technologies necessary to complete all waste treatment. The process to which you are here to contribute will address tank closure and supplemental waste treatment options and the environmental impacts of several alternatives for waste retrieval, treatment, and disposal, and tank system closure.

Why "Tank Systems"?

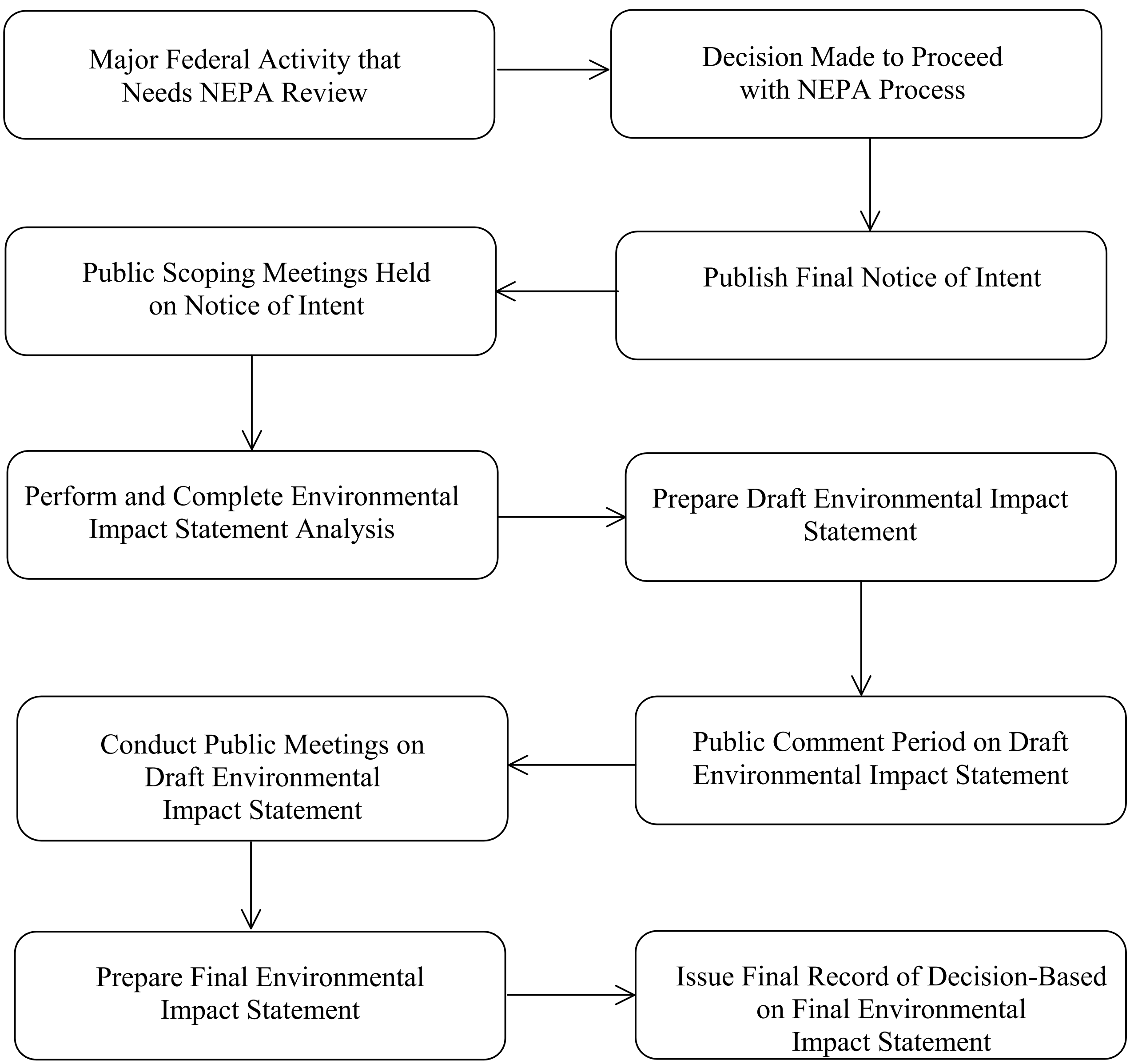
We call them "tank systems" because we are dealing with not only tanks but also an elaborate complex of underground pipes, concrete pits, waste diversion boxes to move wastes from one pipe to another, smaller settling tanks, and lengthy transfer lines.

The *National Environmental Policy Act of 1969* (NEPA) requires federal agencies that propose to take actions affecting the quality of the human environment in a major way to prepare what is called an environmental impact statement (EIS). DOE's intention to close the waste storage tanks in the *single-shell tank* system at Hanford and to develop supplemental treatment of the tank wastes are major federal actions and require an EIS.

Words or terms in *italics* are listed in the glossary, starting on page 17.

The purpose of an EIS is twofold. First, it gives managers the best available information and analysis about the proposed action, including action alternatives and cumulative impacts to both the environment and human health. Second, it allows involvement by the public in the development of alternatives and projected impacts. The EIS will support decisions made by DOE and regulatory agencies, such as Ecology. The actual decisions about waste treatment and tank closure will be made by DOE in a Record of Decision and by Ecology in permits issued under state environmental protection regulations.

A Typical NEPA Process



The first stage in an EIS is a public scoping effort. DOE issued a Notice of Intent (NOI) on January 8, 2003, which describes the proposed scope of the EIS. The NOI is available from DOE's Hanford website, www.hanford.gov/orp. Issuance of the NOI is followed by public scoping meetings. In those meetings DOE will solicit public input on the scope of the EIS and the alternatives to be considered as described in the NOI. DOE has already had internal meetings about the scope of this EIS with the Hanford Advisory Board, Ecology, and the U.S. Environmental Protection Agency. Ecology and the U.S. Environmental Protection Agency, along with DOE, are parties to the Tri-Party Agreement.

Using the input gained from the public scoping process, DOE will prepare a draft EIS document by the end of September 2003. DOE will conduct a second set of public meetings to get comments on that draft EIS document.

The current schedule calls for the final Accelerated Retrieval, Treatment, and Disposal of Tank Waste and Closure of Tanks at the Hanford Site EIS to be available by December 31, 2003 with a Record of Decision issued by April 2004. The Record of Decision will make clear DOE decisions and how DOE considered information from the EIS in reaching its decisions.

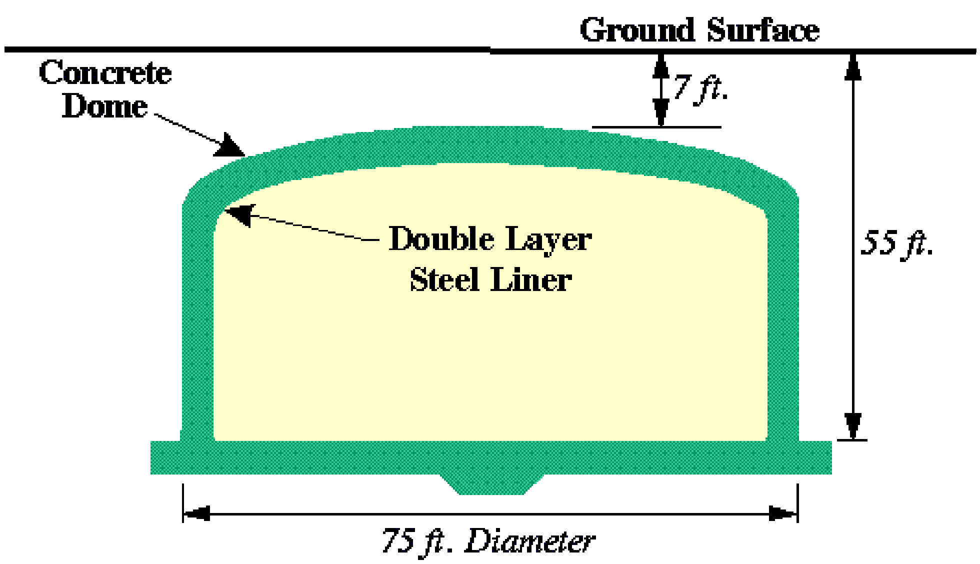
To put the Accelerated Retrieval, Treatment, and Disposal of Tank Waste and Closure of Tanks at the Hanford Site EIS in context, we have provided general information about Hanford's waste storage tanks and tank systems in the following sections.

The Tanks

Hanford's tanks are cylindrical reinforced concrete structures with inner carbon steel liners. Tanks are split into two groups based on their design: 149 single-shell tanks having a single carbon steel liner and constructed from World War II until the mid-1960s, and 28 *double-shell tanks* having two steel liners and built between 1968 and 1986. Both types of tanks are covered with about 10 feet of soil and gravel. They range from nearly empty to nearly full. The total amount of waste in the tanks is approximately 53 million gallons. About 23 million gallons are "saltcake" (moist, water-soluble salts), 12 million gallons are "sludge" (a peanut-butter-thick mixture of water and insoluble salts and salt-containing liquids), and the balance is liquid only. It is believed that at the bottom of some tanks there is "hard-heel" waste made up of many types of materials that perhaps cannot be removed.

The tanks contain about 190 million *curies* of radioactivity. A curie is a unit of measure to describe the intensity, or strength, of radioactivity in a material. (A typical home smoke detector contains about 1 millionth of a curie of radioactivity.)

Double-Shell Tank Schematic



Of the 177 tanks at Hanford, 28 are double-shell tanks. The 149 single-shell tanks have only one steel liner. Both types of tanks have a concrete shell in addition to steel liners.

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The radioactive and chemical contents of wastes in the overall tank systems are generally known. The knowledge we have of tank waste characteristics is based on tank operations records and tank samples taken over the past 50 years. Most tank waste was generated from the reprocessing of irradiated uranium (in nuclear fuel) to extract plutonium and recover uranium for recycling. The first and major step was the dissolution of the irradiated fuel elements with acid. This resulted in a highly acidic waste stream. The dissolution and extraction processes also added organic compounds and salts of various metals. Before the acidic waste was pumped to the tanks, it was neutralized with large quantities of sodium to prevent corrosion of the carbon steel tanks.

The 149 single-shell tanks built until the mid-1960s had a design life of only 10 to 20 years. Waste leakage from those tanks to the soils beneath them was suspected as early as 1956 and was confirmed in 1959. By the late 1980s, 67 of these tanks were known or suspected leakers. DOE estimates that about 1 million gallons of waste had been released to the soils in the tank farms.

(left) An Aerial View of Hanford's Tank Farms

(right) Some of Hanford's Double-Shell Tanks Under Construction, 1984

Approximately 150 square miles of groundwater at Hanford is *contaminated* with chemicals and *radionuclides*. Some of this *contamination* may be attributed to the 1 million gallons of wastes believed to have leaked from the storage tanks. Most of the groundwater contamination was caused by intentional discharges of tank wastes to cribs and trenches on the Hanford plateau and by more than one hundred billion gallons of slightly contaminated cooling water from eight of the production reactors that were discharged to the ground. Less than 1% of the site's total radioactivity has been discharged or leaked to the ground. A portion of these contaminants was trapped in the sediments above the groundwater. Some reached the groundwater to create contaminant levels that now exceed drinking water standards.

Groundwater moving from beneath the Hanford tank farms will eventually discharge to the Columbia River. Estimated groundwater travel time for the fastest moving contaminant plumes from beneath the tank farms to the river is 25 to 50 years.

Some tanks contain various radionuclides and chemicals that have separated into blended layers of liquids, slurries, sludges, and saltcake.

To prevent further leakage, liquids from the single-shell tanks are being pumped into the newer and more durable double-shell tanks. By 2004, the process of minimizing the liquid waste contents of all the single-shell tanks (usually by pumping) will be completed. What will remain in those tanks will be saltcakes and sludge.

Double-shell tanks at Hanford have a design life of several decades. No leaks from any of these tanks have been detected. Several have reached their design life and by 2033, when most are expected to be closed, most of them will have exceeded their design life.

Safety Risks Posed by the Tanks

For years, people have expressed concerns about the potential dangers Hanford tanks pose to workers, the public, and the environment. What conditions cause the safety problems? What has DOE done to manage those risks?

A decade ago, there were thought to be at least four types of safety risks posed by the tanks' contents:

- Hydrogen buildup in the tanks. Hydrogen gas is very flammable, and the concern in the late 1980s was that it could cause a tank explosion.
- Ferrocyanide igniting in the tanks. This chemical compound was added to the tank wastes in the 1950s to reduce the levels of cesium and strontium in tank wastes being discharged to cribs and trenches. There was concern at one time that it could catch fire if mixed with nitrates or nitrites in the tanks.
- High concentrations of organic chemicals igniting in the tanks. Millions of pounds of these chemicals were added to the wastes to separate out strontium, a radioactive element. The concern was that these chemicals could mix with nitrates and nitrites, and would catch fire.
- Plutonium in the tanks causing a chain reaction (criticality). Our best estimate is that the 53 million gallons of tank waste include about 1,200 pounds of plutonium. If enough plutonium were concentrated in a small enough area, it could cause a criticality.

Accomplishments at the Hanford Tank Farms

Since 1996, when the last Hanford tanks environmental impact statement (known as the "Tank Waste Remediation System Environmental Impact Statement") was published, much has happened at the tank farms:

- All four remaining tank safety issues were closed (see above).
- A flammable gas safety issue surrounding the most troublesome tank has been resolved.
- Pumping has been completed on 132 of the 149 aging single-shell tanks, and this effort is ahead of a Consent Decree schedule for completion in 2004.
- Waste storage system safety documentation, equipment, and instrumentation have been upgraded.
- All direct discharges of wastes from the tanks to the soils have been stopped.
- Construction has begun on the Waste Treatment Plant, designed to vitrify the tank wastes.

Congress was so concerned about these perceived risks that in 1995 it placed 25 tanks on a "Watch List." Since then, through a process of research, study, experiments, and complex monitoring of the Watch List tanks, all of those tanks were removed from the Watch List in 2001 and the Tri-Party Agreement commitment to evaluate these tanks was met. DOE showed Congress that none of the four issues above presented a significant risk in the Hanford tank farms.

Waste Types in the Tank Farm System

High-level waste is a by-product of reprocessing spent nuclear fuel. This waste requires radiation shielding and special handling techniques. Its disposal requires special measures to isolate it permanently from humans and the environment.

Transuranic waste is material contaminated with radioactive elements with atomic numbers greater than uranium. This waste does not require as much isolation as high-level waste. However, it cannot be disposed of in a facility located at or just below ground level. DOE disposes of these wastes at the Waste Isolation Pilot Plant in Carlsbad, New Mexico.

Low-activity waste remains after separating as much radioactivity (consisting of key radionuclides) as technically and economically possible from high-level waste. Low-activity waste may be disposed of just as low-level waste (below) if certain additional requirements are met.

The least hazardous radioactive waste is **low-level waste**. It is all radioactive waste that is not high-level waste transuranic waste, low-activity waste, spent nuclear fuel, or by-product material. It may be disposed of in a near-surface facility.

Hazardous waste is ignitable, corrosive, reactive, toxic, and persistent in the environment, exhibits dangerous characteristics, or appears on special lists published by the U.S. Environmental Protection Agency and the Washington State Department of Ecology. This waste may cause or contribute to an increase in health hazards when treated, stored, transported, or disposed of improperly.

Mixed waste is both hazardous or dangerous and radioactive.

Waste Retrieval: How Will the Waste Be Dislodged and Moved?

As part of the cleanup process, tank waste is planned to be removed from all 149 single-shell tanks. It will then be transported to processing facilities that may be located adjacent to or up to several miles from the tanks.

One issue to overcome during accelerated waste retrieval is having adequate space in the 28 double-shell tanks. The space issue is a delicate balance of retrieval and closure schedules for the single-shell tanks and limited WTP capacity for treating the waste. The plan is to stage the waste retrieved from the 149 single-shell tanks into the double-shell tanks whenever possible. From the double-shell tanks, the waste will either be pumped to the WTP to be made into glass or treated by a supplemental treatment technology. Double-shell tank space is very limited until treatment begins. Proposed solutions range from managing the retrieval sequence of the single-shell tanks or processing the double-shell tanks to a higher level to concentrating the wastes through evaporation, to finding different storage capacity.

Because we have not yet retrieved extensive amounts of waste, it is not clear that one single retrieval technology will be effective in getting 99% of the wastes out of the single-shell tanks. The saltcakes and sludge in the tanks are varied and are in many forms to yield to just one method. The most commonly used method in past retrieval efforts has been sluicing. Sluicing is the spraying of liquid at high pressures and volumes into the waste to break apart the solids for pumping out of the tank. The disadvantage of past-practice sluicing is that it puts large volumes of liquids into tanks that are known or suspected leakers, potentially causing more leakage into the soils beneath the tanks.

Another promising retrieval technology is called “saltcake dissolution.” A solvent, primarily water, is sprinkled into the tanks with this type of waste structure to dissolve the saltcakes. As the saltcake dissolves, the liquids are pumped out of the tank. This technology uses lower volumes of liquids which reduce the potential for leaks and may cost less than older sluicing technologies.

A third retrieval technology combines confined sluicing and robotic technology. A robotic crawler vehicle, equipped with a mast carrying a vacuum system capable of sucking waste sludge out of the tank, would be put into a tank. The vehicle would also have mounted sluicing nozzles and would direct a low volume of high-pressure fluid onto the sludge, creating a slurry mixture that would be sucked through the mast out of the tank. This technology would also reduce the potential for leaks.

DOE is planning actual in-tank demonstrations of saltcake dissolution and robotic sluicing, as well as other promising technologies.

All of the discussion so far has focused on retrieval of the single-shell tank waste. That will require a complex infrastructure and miles of pipes, much of it already in place, for moving wastes across the site from west to east, from the single-shell tanks into the double-shell tanks.

Treating the Tank Wastes

After retrieval of the wastes, the next step in the tank waste cleanup process is waste treatment. The waste must be treated and packaged into a form that will minimize *radiation* and hazardous chemicals reaching the environment and coming into contact with humans at levels that exceed regulatory limits or pose risks to health.

The first step in preparing tank wastes for final treatment is called pretreatment. This is a critical step in the tank waste cleanup process because it is when key radionuclides are separated from the bulk of the chemicals and metals making up the waste. Pretreatment can save time and money, and reduce the volume of *high-level waste* to be later disposed of in the Yucca Mountain Geologic Repository in Nevada.

After pretreatment, the tank waste must be converted into a durable, solid form before it is disposed. This is to minimize the threat of releasing radioactive and chemical materials into the environment. The low-activity portions of the tank waste can be turned into a waste form (some type of glass, grout, or dried and packaged material) and disposed of in a near-surface facility to allow later retrieval if needed. The high-level radioactive waste must be turned into a form that is safe for interim storage at Hanford until Yucca Mountain can receive the waste for permanent disposal deep beneath the earth's surface.

In 1988, DOE issued a plan to treat the tank wastes. It called for building a vitrification plant to treat the wastes in the 28 double-shell tanks. The plan was stopped in the early 1990s for two primary reasons. First, the plant as it was conceived did not have enough capacity to make glass out of the high-level waste fraction of the wastes in the required time frame. Second, the facility that would be used to pretreat the wastes, an old fuel processing plant at Hanford, was found to be inadequate for safety and cost reasons.

DOE examined a new waste treatment plan in 1996 in the Tank Waste Remediation System EIS. This plan, selected in that EIS Record of Decision and known as "Phased Implementation," proposed a demonstration-scale (small-scale) WTP that would begin operations in 2002. The demonstration plant would serve as a way to gather information and reduce uncertainties before a decision to build a larger plant to treat the rest of the tank wastes.

The intent of DOE was to vitrify all the wastes, both high-level and low-activity contaminant streams, from all 177 tanks. However, the demonstration-scale WTP was designed to make glass of only 10% of the wastes by 2012. Following completion of the demonstration phase, DOE would have to expand the WTP or build a second, larger plant to treat all the wastes by 2028, the milestone date in the Tri-Party Agreement.

In 1998, DOE decided to make the WTP a full-scale vitrification plant and to delay startup of the plant until approximately 2007. Under this new plan, the plant would have the capacity to treat about 10% of the tank waste by 2018. In that year the capacity of the plant would be doubled. Even with the added capacity to make glass, it still would have the capability to vitrify only about 50% of the wastes by the 2028 milestone date. DOE will need added treatment capability to supplement the WTP as it is planned now to meet that deadline. DOE is still committed to treating all tank wastes by 2028. The Accelerated Retrieval, Treatment, and Disposal of Tank Waste and Closure of Tanks at the Hanford Site EIS will look at several ways to do that.

One option is to make a number of changes to the existing design of the WTP. More pretreatment capacity, changes in high-level waste melter designs and capacities, and added *low-activity waste* treatment capacity would all increase the output of the plant. The added low-activity waste treatment capacity would be developed through expanded vitrification volume or through supplemental treatment technologies that would result in a waste form other than glass. This option could include adding treatment systems to supplement the capacity of the WTP.

A second option is to add sulfate-removal capability to the WTP. Sulfates in the low-activity waste stream make the waste more difficult to vitrify.

A third option is to use "supplemental" waste treatment technologies outside the WTP. One technology that will be evaluated is "containerized grout." This would be different from the previously proposed 1980s grout concept in several ways: the grout would be stored in easily retrievable containers; the more dangerous radionuclides would be separated from the waste before it is grouted; and more durable grout mixtures would be used.

Another supplemental treatment technology that may be evaluated is "bulk vitrification." Wastes would be made into glass outside the WTP in very large containers. The waste melter would itself be part of the container and disposed of after each use.

Finally, analysis may show that the wastes in about a dozen tanks could be classified as *transuranic* or *low-level wastes.* The transuranic wastes could be treated and packaged and transported to the Waste Isolation Pilot Plant in New Mexico. This would also free up additional WTP capacity for the high-level wastes that must be vitrified.

All of these options for increasing waste treatment capabilities and for re-designating wastes at Hanford are still in the evaluation stage. Ecology would have to approve permits and modifications to the Tri-Party Agreement to increase DOE capability to treat wastes before supplemental treatments could be implemented.

Disposing of the Treated Wastes

Once radioactive and hazardous tank wastes are converted into their final forms (some type of glass, grout, or dried and packaged material), they must be disposed of in a way that is safe for humans and the environment.

The high-level and low-activity waste forms will be disposed of differently. The high-level waste glass produced at WTP will be poured into large steel canisters. The canisters will probably be stored initially at Hanford, and then moved to the national repository at Yucca Mountain starting in 2015. Disposal at Yucca Mountain is meant to isolate the wastes from the environment for a very long time (thousands of years). It is possible that Yucca Mountain will not be ready for high-level waste storage on time or, in later years, will not have enough space for all of Hanford's high-level waste canisters. Some high-level waste glass may have to be stored for a very long time at Hanford.

Options for disposing of the treated low-activity wastes are being studied. The disposal site will likely be where the waste tanks are on the plateau at Hanford. The plateau's ground surface is 200 to 300 feet above the water table. The plateau is about 6 miles from the Columbia River at its nearest point.

Coming to Tank Closure

The name of the EIS that will be prepared is "The Accelerated Tank Retrieval, Treatment, and Disposal and Closure of Tanks at the Hanford Site EIS." After the wastes have been removed from the tanks, the tanks themselves must be "closed." Looking at what closure means and the environmental impacts of closure is a major purpose of this EIS.

The Tank Waste Remediation System EIS, published in 1997, did not examine tank system closure. When that EIS was prepared, DOE believed there was not enough information to be able to examine the impacts of tank closure. Before making decisions, DOE wanted to know more about how much tank waste would be retrieved and treated, how much would be left in the tanks, and how much contamination would be left in the related pipes and pits and converter boxes. In 1997 there was no real pressure to answer those questions.

Six years later, DOE does know more. DOE knows more about how contaminants that have leaked from tanks move in the soils and about tank retrieval methods. It knows more about processes for making glass from wastes. The Tri-Party Agreement now calls for beginning efforts to close several tanks in 2004 timeframe. It makes sense to evaluate the impacts of tank closure now.

Closure is the final step in the process of disposing of tanks' chemical and radioactive wastes. Federal and state laws describe two options for closing tanks. The meaning of "clean closure" can vary. It could mean that chemical and radioactive wastes associated with a tank and its supporting structures have been removed. The tanks would be filled with inert material such as sand, gravel, or cement to prevent collapse and the waste transfer pipes cleaned and plugged. Because the waste has been removed, the tanks may remain buried in place. Soils contaminated by tanks that have leaked approximately 1 million gallons of high-level wastes must be cleaned up, as well as miles of pipeline and other support equipment.

A more thorough clean closure approach would include tank removal. After wastes are retrieved from the tanks, the tanks would be broken apart. The tank pieces (and pieces of support structures) would be removed from the tank farms for treatment, disposal, and monitoring, probably at another location on the Hanford site. Removal of just the 149 single-shell tanks would be the equivalent of moving 21,000 tons of steel (enough to build 14,000 cars); 745,000 cubic yards of concrete (enough for the foundations of 30,000 1,200-square-foot homes); and 130,000 cubic yards of contaminated soil (enough to fill about 30 Olympic-sized swimming pools).

What Do Waste Treatment and Tank Closure Mean to You?

Tank waste treatment and disposal, and eventual tank closure, mean different things to different people. To some, the tanks and tank farms on the Hanford plateau will only be cleaned up when the tank farm areas are available for industrial or residential uses. At the other end of the spectrum, some people would settle for having the Hanford plateau be a "sacrifice zone" where a very long-term government presence would be needed to limit human access.

Each definition of tank cleanup—at either end of the spectrum and at points in between—would affect Hanford cleanup costs, schedules, human health risks, and technology needs in different ways. Some of the problems with Hanford's tanks wastes may only be handled, because of cost implications, by technologies that may have to be adapted to the complexities of Hanford's tank wastes.

Much remains unknown about tank waste cleanup. Different definitions of cleanup are accompanied by different risks, both during cleanup and for many years into the future, and different costs. This is why it is important to evaluate in this environmental impact statement the environmental consequences of various cleanup alternatives.

Taxpayers have different values and preferences about tank waste cleanup. What are your values and preferences for tank waste cleanup? How would **you** answer these questions?

- **What level of tank waste cleanup is necessary?**
- **How should the land on the Hanford plateau be used after cleanup?**
- **What should be the final waste forms for low-activity waste?**
- **What is an acceptable level of human health risk, both while the tanks are being cleaned up and in future generations?**
- **To what degree should tank waste cleanup decisions be consistent with other Hanford cleanup decisions?**

The Accelerated Tank Retrieval, Treatment, and Disposal of Tank Waste and Closure of Tanks at the Hanford Site Environmental Impact Statement is the first study that will seriously look at what it means to finish cleaning up the most highly contaminated part of the Hanford site, the tanks, and tank farms. It raises many questions about what nuclear waste cleanup means to the citizens of the United States.

Radiation *exposure* to workers doing the cleanup tasks would be high, even though most of the wastes and therefore most of the radioactivity already would have been retrieved from the tanks in the removal scenario. Both clean closure options would likely cost more and would require a higher level of exposure of workers to radioactively contaminated materials than the second alternative: landfill closure.

Landfill closure means leaving the emptied tank structures, with their residual contamination, contaminated soils, and support equipment in place. The tanks would be structurally strengthened against subsidence by filling them with sand, gravel, or cement. The tanks and surrounding contaminated soils may or may not be treated to reduce contamination or to create barriers against further spread of contamination. Aboveground barriers may be placed over the tanks. The barriers may be built of multiple layers of soil and rock, possibly with an asphalt sublayer. The sides of the barrier may be reinforced with rock to protect the barrier against wind and weather erosion.

The landfill option would likely cost less than either clean closure option. It would require less worker exposure to radioactive contaminants and would have less risk of releases of airborne contaminants to the environment. At the same time, landfill closure may be less effective in the long term in preventing the spread of contaminants to the groundwater and to the Columbia River. More detailed evaluation of landfill and clean closure in the EIS may result in different answers.

The selection of a tank closure option will consider:

- The health risks and costs of decontaminating and/or removing tanks versus leaving them in place with residual contamination
- Available technical and regulatory options applied to both the clean closure and landfill closure alternatives
- Regulatory policy, as set by Ecology, and stakeholder preferences.

Land Use

One of the most important questions about Hanford tank waste cleanup is land use. The land currently occupied by the tank farms on the Hanford plateau might eventually be used for agriculture, for industry, or it might be withdrawn indefinitely from uses other than nuclear waste management. Each use would mean different near- and long-term impacts to the environment. Each would require a different closure strategy and a different cost to the taxpayers. The need for cleanup standards tied to a long-term land use strategy is clear. This issue will have to be dealt with before the tank systems can be closed.

Furthermore, the land use strategy adopted as a basis for closing tank systems will need to consider land use decisions for the Hanford plateau areas surrounding the tank farms. The tank farms are surrounded by numerous waste disposal and hazardous and *mixed waste* sites that will be closed by other programs managed both by DOE and others at Hanford. The various long-term land use strategies on the Hanford plateau will have to match up or clean-up effectiveness will suffer.

Glossary

Closure – Actions that happen after tank wastes have been retrieved from the tanks. Those actions could include but not be limited to decontamination and/or removal of tanks and ancillary tank equipment, treatment or removal of contaminated soils beneath the tanks, placement of long-term barriers over tanks, and treatment of groundwater.

Contamination – Radioactive or hazardous chemical materials where they are not wanted or in a concentration that threatens human health or environmental health.

Curie – A unit of radioactivity defined as the quantity of any radioactive nuclide in which the number of disintegrations per second is 37 billion. It was originally defined as the amount of radioactivity in 1 gram of the isotope radium-226. A typical home smoke detector contains about 1 millionth of a curie of radioactivity.

Disposal – Removal of contamination or contaminated material from the human environment, although with provisions for monitoring, control, and maintenance.

Double-shell tank – A reinforced concrete underground vessel with two inner steel liners. Instruments are placed in the space between the liners (the annulus) to detect liquid waste leaks from the inner liner.

Exposure – The act of being exposed to a harmful agent, such as breathing air containing some hazardous agent like radioactive materials, smoke, lead, or germs; coming in contact with some hazardous agent (for example, getting radioactive material or poison ivy on the skin); being present in an energy field such as sunlight or other external radiation; or ingesting a hazardous agent.

High-level waste – Radioactive material (containing fission products, traces of uranium and plutonium, and other radioactive elements); it results from the initial chemical reprocessing of nuclear fuel used in nuclear reactors.

Irradiate – To expose uranium metals to neutrons to convert them to plutonium.

Low-activity waste – The chemical waste that remains following the process of removing as much radioactivity as is technically and economically practicable from high-level waste. When additional requirements are met, low-activity waste may be disposed of as low-level waste in a near-surface facility.

Low-level waste – All radioactive waste that is not high-level waste, transuranic waste, spent nuclear fuel, or by-product material and may be disposed of in a near-surface facility.

Mixed waste – Waste that is both hazardous or dangerous and radioactive.

Radiation – Particles or energy waves emitted from an unstable element or nuclear reaction.

Radioactivity – Property possessed by some isotopes of elements of emitting radiation (alpha, beta, or gamma rays) spontaneously in their decay process.

Radionuclide – Radioactive atomic species or isotopes of an element.

Single-shell tank – An older-style underground vessel with a single steel wall liner surrounded by reinforced concrete. The domes of single-shell tanks are made of concrete without an inner covering of steel.

Tank waste – Radioactive mixed waste materials left over from the production of nuclear materials and stored in underground tanks.

Transuranic waste – Waste contaminated with alpha-emitting transuranic elements with half-lives of greater than 20 years in concentrations of more than 1 ten-millionth of a curie per gram (0.03 ounce) of waste.

Waste – Unwanted materials left over from production of nuclear materials. Waste was either stored in aboveground or belowground structures or released into the environment.